

BUCKMASTER, (A. H.)

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Hospital for Mental and Nervous Diseases; Fellow of the N. Y. Obstetrical Society.

Prize Essay of the Alumni Association of the Long Island College Hospital for 1888.

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THE GALVANIC TREATMENT OF FIBRO-MYOMATA.*

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Too often the profession is startled by the birth of novel therapeutic measures which are based upon clinical cases and confirmatory investigations, and which fail to fulfill their promises and die a speedy death; fortunate indeed if the amount of mischief accomplished be small. The effect is to throw discredit on new things and to cause them to be regarded with distrust, however eminent their sponsors, and however complete may be the proof of their right to live. The professional bigotry that prevented the early recognition of Jenner's great discovery is not possible to-day, but the hypercritical method in vogue often prevents justice being accorded to work of the highest order. The profession is not always to blame for slighting new methods that promise great results. New plans of treatment claiming the attention of physicians by the clinical evidence adduced, the value of which depends largely on the honesty, experience and ability of the investigator, cannot be tested by experimental research in the hurry of an active professional life, and the doubter who follows in a perfunctory manner the directions of the enthusiast may arrive at conclusions more remote from the truth than the latter. It is only when scientific experimental research goes hand in hand with clinical investigation that error is eliminated as much as possible and theories, if found worthy, are supplied with the strongest claims for consideration. In the consideration of the subject of this paper by writers in general, experimental research has been almost entirely ignored, and my desire to pointedly direct attention to this is the *raison d'être* of this essay. My clinical experience in the general treatment of fibroid tumors of the uterus is based on the study of sixty-eight cases, in twelve of which the uterus was removed. If the experimental work in this paper accomplishes only the discontinuance of the improper term electrolysis, I believe that an important misconception of the treatment will be removed.

* Prize essay of the Alumni Association of the Long Island College Hospital for 1888



For the perfect understanding of what follows I will give a brief description of fibro-myxomatous tumors. They consist of bundles of fibrous tissue, non-striated, but rarely striated muscular fibres, blood-vessels, nerves and lymph spaces. They present infinite variations between two forms which are clinically known as the white or hard fibroid, and the red or soft fibroid. This difference in appearance is caused by the preponderance of blood-vessels and muscular tissue in the one case, and of white fibrous tissue in the other, indeed the latter variety has so poor a vascular supply that observers have rarely been able to inject its blood-vessels from the uterine artery. In some instances there is a distinctly cavernous structure of the vessels about these growths and from these receptacles comes the nourishment of the fibroid. I have frequently seen fibroids whose blood supply was in no small part derived from the adhesions which were the result of inflammatory action caused by the irritation of the tumor. "In rare cases the blood-vessels become wide and dilated, so that the tissue is pierced with capacious channels and cavities containing blood. In other instances the lymphatics are widely dilated."* The blood-vessels are said by Klebs† to be somewhat peculiar. There are numerous capillary blood-vessels containing large nuclei, supported by a thin layer of fibrous structure and surrounded by muscular tissue. Between the sheaths of the vessels and the muscular bundles are wide spaces containing white blood cells. A cavernous structure thus originates which is not found in normal uterine tissue, and it is very probable that these cavities are to be regarded as lymph spaces in which the blood-vessels are suspended, as it were, by fine bands of connective tissue. On section I have found the exuding fluid to be markedly acid in reaction. This is probably due to the degenerative change that takes place during *rigor mortis*. From the above description it will readily be seen that tumors differing so widely in the proportion of the tissues that compose them, must respond differently to agents whose action depends on the predominance of one or other of their component parts. This may perhaps explain the conflicting results obtained by investigators. Clinically speaking, the uterine fibroid is a mass of fibroid and muscular tissue in the pelvis or abdominal cavity, that by its size presses upon surrounding structures; by its weight drags upon contiguous organs; and by its tendency to hæmorrhage causes at times fatal blood impoverishment. One can never predicate the symptoms by the size of the tumor. Some as large as a child's head may be unnoticed, while others no larger than a hen's egg may make the

* Gen'l. Path. Anat., Ziegler, p. 197.

† Handb'ch d. Path. Anatomie.

life of the patient miserable. This was shown by the cases of Mrs. G. and Miss D. The former sought the writer's treatment for sterility. She had no pelvic or abdominal symptoms, but a fibroid as large as a child's head was found, and the patient was utterly unaware of its presence. On the other hand, Miss D. suffered excruciating pain for many years from an irritable bladder. She was a school teacher by occupation, but unable to attend to her duties. The trouble arose from a fibroid, the size of a very small lemon, in the anterior wall of her uterus.

The distressing symptoms accompanying fibroid tumors are worthy of attention, because their permanent removal is in some cases tantamount to a cure, and this would be the case in the unmarried, particularly those where matrimony was but little apt to be contemplated.

These distressing symptoms are :

1. Pain. (*a.*) From inflammatory products excited by the presence of the tumor.

(*b.*) From direct pressure on nerve trunks.

(*c.*) Vesical* tenesmus* caused by tension on the neck of the bladder; this may eventually lead to cystitis.

(*d.*) Rectal tenesmus.

2. Chronic poisoning from absorption of fecal matter, the evacuation of which is interfered with by the tumor mass.

Dr. Sir Andrew Clark, in a very interesting and instructive paper on the chlorosis of girls,† draws attention to the importance of fecal accumulation in causing this condition. The accumulated feces not only undergo changes in themselves, but promote changes in the mucous membrane with which they are in contact. As one of the results of these changes, both chemical and biological, there are produced new substances, ptomaines and leucomaines, which are injurious to the organism. To this condition is the anæmic and cachectic appearance of patients with fibroids often due, and if by any means we can lessen the size of the tumor mass great relief may thus be afforded in permitting the intestines to rid themselves of their dangerous contents.

3. Hæmorrhage. (*a.*) From fungous endometritis, which the writer has found to exist in almost all the cases where the uterus was removed for bleeding fibroid.

(*b.*) From passive hyperæmia. No one will dispute this cause who has seen the large congested os that will bleed freely even from the

* The writer holds with Dr. T. Addis Emmet that the mere pressure of the fibroid tumor on the bladder very rarely, if ever, leads of itself to irritation of that organ.

† British Medical Journal, 1888.

prick of a pin. Gusserow has called attention to the fact that the portion of tissue over the tumor may become thin and atrophied, and that there will be a collateral hyperæmia of the remaining portion of mucous membrane. Rokitansky reported a case where a fatal hæmorrhage from a varicose vein of the bladder occurred in a patient affected with a fibroid.

4. Discomfort from weight of the tumor mass. This is the only symptom in some cases, and may be relieved by a properly fitting abdominal support.

The above symptoms are profoundly effected by the galvanic current. The pain is checked, and to what this cessation is due is a matter of conjecture. We know that an inflammatory exudate is often quickly absorbed under influence of the galvanism, and some have offered this as an explanation. The decrease in size of the fibroid lessens the pressure symptoms, and the cauterizing effect in the uterine mucous membrane places an impassable barrier between the blood-vessels and the cavity of the uterus. We believe that the hæmastatic effect of the positive pole is made clear by this mechanical explanation; iodine, the actual cautery, and other agents of this character would have proved themselves much more potent had the skill of the gentlemen using them been sufficient to have applied them thoroughly to the surface from which the blood passed. It is oftentimes a matter of the utmost difficulty to pass a sound to the end of the uterine canal in these cases. The life history of these tumors is very irregular, a large proportion of them disappearing or causing no further trouble at the menopause.* In those cases where the symptoms are very distressing, and the menopause is far distant, life becomes a burden. Before the treatment under discussion was inaugurated, the only effective alternative was removal of the ovaries or of the uterus. When the tumor is large, Hegar's operation is usually impracticable, because the ovaries are so bound down that hysterectomy becomes an operation involving less risk.† Not only are the chances of immediate recovery from the operation very bad—I do not think the mortality is overstated at 30 per cent. even in the hands of skillful laparotomists—but the possible pains of a large cicatricial mass in the abdominal wall or peritoneal adhesions may prove greater than existed before the operation.‡ The writer has in mind two cases where life was miser-

* Dr. T. A. Emmet, at the January meeting of the N. Y. Obst. Society, 1886, remarked that when preparing the statistics for his book he found about 19 per cent. of the cases either disappeared after the menopause or the patient ceased to suffer from its presence.

† "Contributions to the Surg. Treat. of Tumors of the Abdomen," Keith.

‡ The intraperitoneal method so ably advocated by Martin has not found much favor in this country.

able before the operation, and almost unbearable a year after it was performed. I will venture to say that no surgeon was ever justified, however good his statistics, in subjecting his patient to the risk of an operation in the case of a fibroid, unless the symptoms were of a marked character, and the conclusion that follows from this statement is that if galvanism will relieve the symptoms, no one is justified in doing a hysterectomy at the present day. This is what the conservative Dr. Thomas Keith,* of Edinburgh, remarks. I quote from the *British Medical Journal*: "Fortunately for those afflicted with internal tumors it matters but little which of the old ways of operation is the best. . . . The treatment introduced by Dr. Apostoli must take precedence of all others. The success of this treatment is a great fact, and I accept, *toto animo*, his teachings. I do not speak without some experience of his practice." He then remarks that he has treated a large number of patients. He concludes with this statement: "I would consider myself guilty of a criminal act were I to advise my patient to run the risk of her life—and such a risk—before having given a fair trial to this treatment, even were I sure that the mortality would not be greater" than that of my private cases.

Dr. Apostoli, in a paper before the American Gynæcological Association, said he had employed electrolysis in nearly three hundred cases. The uterine fibromata almost invariably diminished in size, but never totally disappeared.

Dr. Skene, in a personal communication to the writer, speaks in the very highest terms of this treatment. The following case was narrated to me by Dr. Louis D. Mason, of this city. He sent a young lady suffering from a fibroid which reached above the symphysis, to Dr. Skene's private sanitarium. After a few months' treatment she returned home, and there seemed to be a disappearance of the growth. Since then she has married and is now the mother of a fine child. With such a success as this, we can hardly be surprised at the doctor's partiality for the method.

Dr. John Byrne, who is an authority on electrical matters, reported the favorable treatment of a case in the proceedings of the N. Y. Obstetrical Society for January, 1887. The patient, after treatment, suffered from a severe attack of peritonitis, but eventually recovered. In this case, puncture by the abdomen was practiced.

"The hopefulness of the treatment has always seemed to me," says the great English obstetrician, Dr. W. S. Playfair,† "to be in the well-known clinical fact that uterine fibroids often undergo spontaneous absorption, as, for example, during involution following labor; and it

* *British Medical Journal*, Dec. 10, 1887.

† *British Medical Journal*, June, 1887.

seems not unreasonable to suppose that we may find a means of doing by art what is often done by nature under conditions as yet but little understood, but well worthy of further study."

Dr. W. Woodham Webb, at the suggestion of Sir Spencer Wells, made a thorough investigation into the methods of Apostoli. He remarks that "for more than six months I have regularly attended his *clinique*, spending many hours a day questioning and examining his patients, noting what was done. . . . The upshot of all this is that I am perfectly satisfied much good has been done; many women have been gradually, and without suffering, set up in health, who would under ordinary circumstances have been condemned to the risks of some cutting operation."

Mr. E. Stephenson, electrician to St. Bartholomew's Hospital, says: "I have been associated in the treatment by electricity in two cases of fibroid tumor of the uterus, both of which improved."

Dr. Geo. J. Engелеmann, of St. Louis, states that he has destroyed neoplasms, from the size of a walnut to that of a hen's egg, in three sittings of five minutes each.

Dr. W. H. Baker says: "My experience in the application of electrolysis in the treatment of fibroid tumors of the uterus extends to fourteen cases, the results of which, so far as relieving the suffering dependent on the existence of the growth, have been highly satisfactory; and, so far as arresting, diminishing the size of, or causing the entire disappearance of the growth are concerned, fairly satisfactory, viz.: in one case the tumor entirely disappeared; in twelve cases the tumor diminished one-third to one-half of its size. In one of these cases, however, there is now some indication of a return of the growth accompanied by suffering. In one case, although the suffering was greatly relieved by this treatment, there was little or no diminution in the size of the tumor." The doctor has made no attempt to cull all the published cases, but mentions the views that seemed most valuable.

Dr. Marie B. Werner states that she saw Dr. Apostoli at his clinic, "and the patients without exception expressed themselves much improved by the treatment." She reports six cases, three cured, three benefited.

Those who are not convinced by personal experience can hardly remain incredulous in the face of such evidence as that we have given, on the authority of men who are not only eminent on account of professional qualifications, but men whose honesty cannot be gainsaid.*

* Since the above was written there has been some unfavorable testimony; of fifteen patients treated, Chadwick lost two. N. Y. Med. Jour., vol. 46, p. 385. In the Arch. d'obst. et de Gyn. (Jan., 1888,) Dr. D'Angel Villa, a clinical assistant of

Historical References.—In the *Medical and Surgical Reporter* of February 8th, 1873, appears the report of a case of fibroid tumor of the uterus which was treated by a strong galvanic current under the direction of Dr. Ephraim Cutter, of New York. Dr. Gilman Kimball directed the second application, and the names of those gentlemen have been indelibly stamped on the procedure as pioneers. Their attention was called to the subject by the success attending the treatment of a venous tumor of the neck by Dr. Lincoln,* of New York. The method pursued was that of puncturing the tumor through the vaginal wall in two places. A three-cornered needle was used, made of a surgeon's director and japanned at the larger end, leaving a free surface of two and seven-eighths inches. While it was recognized that the treatment pointed out by these gentlemen was potent for good, a number of disastrous cases (some of whom died) deterred the profession generally from taking up their methods. Dr. Cutter reports the results of fifty cases treated, as follows :

| | | |
|------------------------|--------------------|--------------------------|
| Series 1.—Non-arrests, | Seven cases. | } Total, fifty cases. |
| Series 2.—Fatal, | Four “ | |
| Series 3.—Arrests, | Twenty-five cases. | |
| Series 4.—Relieved, | Three “ | |
| Series 5.—Cured, | Eleven “ | |

In 1878 Dr. N. Freeman, of Brooklyn, reported a case of galvanic treatment of a fibroid tumor, where a consultation of a number of eminent Brooklyn surgeons had decided that no surgical interference was justifiable. The doctor used a straight, round-pointed needle, and pushed it through the abdominal wall to within a short distance of a sail needle passed through the uterine canal into the tumor. Both needles were insulated within an inch of their point. Since this time, Dr. Freeman has used the method of abdominal puncture. His use of a round needle is a great advantage because less liable to be followed by hæmorrhage (separating the tissues instead of cutting them); but we believe puncture through the abdominal wall should never be practiced. The writer has seen the surface of a fibroid covered with veins, some as thick as one's thumb, and we cannot conceive it justifiable to run the risk of peritonitis by this method when a much safer and probably as effective a method is known. For this we are indebted to the indefatigable industry and ingenuity of Dr. G. Apostoli, of Paris, for some years a surgeon in the French army; and his attention was

Dr. Doleris, states that the results obtained in the clinic were not satisfactory either as regards disappearance or marked diminution in size of the growth. He deemed the method a palliative one, and declares that the views he expressed are those of Dr. Doleris.

* Lincoln, R. P., *Med. Rec.*, Dec. 15, 1870, vol. v, No. 20.

directed to the subject of electrical therapeutics by Dr. Tripier. In 1884 he presented a memoir to the Academy of Medicine, giving an account of his manner of treatment. He revolutionized the matter, or, rather, he infused into it new life by two things; one was the use of galvanometer, so that the current strength* could be accurately measured; and the other was to so diffuse the current over the abdomen, by means of a broad electrode of clay, that the patient was able to bear very powerful currents without puncture. He also made use of a platinum probe in the uterus. He placed the method on a scientific basis, and it would be much more reasonable to call it Apostoli's method than the treatment of fibroids by electrolysis, which is a very misleading application of the term.

In the face of these facts, we would scarcely believe that any one would wish to detract from the credit that belongs to Apostoli. This, however, is the case. Mr. Tait, as usual, claims precedence. He states, in regard to a certain occasion, that by using a number of elements "of small and uniform size . . . with constant replacement of precisely the same exciting fluid, the dosage was precise and accurate." (?) The absurdity of this remark scarcely needs consideration. It simply shows that the writer was ignorant of the practical matters connected directly with the subject he criticises. He further states that he used a galvanometer with an ordinary angle measurement, "and this told quite as much as any instrument graduated into ampères." Comment is unnecessary.

At the International Medical Congress at Copenhagen in 1884, Dr. Menière, of Paris, reported six cases treated by electro-puncture in which there was complete amelioration of the symptoms and disappearance of the fibroid.

Dr. George J. Engeleemann read a very exhaustive paper before the American Gynæcological Society in 1886 on the subject of electricity in gynæcology. He drew attention to the importance of the definite size for the electrodes, and suggested that the abdominal plate or, as he very nicely expressed it, the dispersing electrode, should be "3½ by 4½", or "4½ by 6½", or "6½ by 9¼ or 10". It seems to the writer that this would be better expressed by stating the number of square inches of contact, for it is often convenient to cut the plate so that it will fit the abdominal wall. The importance of having a large abdominal electrode is made manifest when a patient is treated without using an anæsthetic; for, where a small contact causes pain, a larger one may be absolutely painless. To those who have not a clear conception of the term intensity or current strength, the following comparison

* The term "current strength" is much preferred to the term "intensity," which is almost obsolete among electricians.

may be of service. We may imagine a wind of a definite velocity and of a definite height sweeping over the country, and the trees and herbage that are swayed by its gentle pressure will thrive from the better circulation induced by their motion. If the same breeze is confined to one twentieth of the country, other conditions being equal, it will become a wind storm, and the corn will be thrown down and the branches broken off trees; but, further, if we confine the wind to a much less territory, we have a hurricane that uproots the trees, throws houses about like playthings, and leaves desolation and ruin in its train. Yet there is always the same amount of energy, only in case of the hurricane it is concentrated. So a current of the same intensity may blister or not be felt according as it is diffused. Intensity is synonymous with current strength, which is a much better term; it is this that is measured in ampères. A current which is much diffused may act as a tonic; while, if it is much concentrated, it may act as a caustic. The practical lesson this teaches is that we should be careful with a current passing through the peritoneum in order to reach the tumor, particularly when the patient is under the influence of an anæsthetic and pain ceases to be present to give the signal of danger referable either to the abdomen or pelvis. Apostoli says: "Il faut que toute operation soit uterinement tolerable."

The next suggestion of importance was made by Dr. Franklin H. Martin, of Chicago, who indicated that two square centimetres of uterine electrode with a current of fifty milliampères, or four square centimetres with one hundred milliampères of current would accomplish both the checking of hæmorrhage and the absorption of the fibroid. The definite size of the exposed surface of the electrode, together with the definite intensity of current, is a great advance. The proportions given by Dr. Martin will give good results, as the writer can attest. Dr. Martin did more than the others in an experimental way; he watched the effect of the electrodes on the tissue outside of the body.

Dr. Robert T. O'Callaghan,* in a communication to the *British Medical Journal*, refers to the frequency of diseased appendages, and implies that they exist in a large proportion of the cases of myoma, and draws the conclusion from this that the treatment is dangerous. This is quite contrary to the writer's experience; but, as the doctor is a follower of Tait, his enthusiasm in this direction may be accounted for. He also calls attention to the intimate relation between these tumors and the menstrual function, and it is undoubtedly a fact that their presence is chiefly noted when this function is in operation; but

* *British Medical Journal*, July 30, 1887.

Dr. O'Callaghan draws an erroneous conclusion when he states that there can be no security of cure except by the arrest of the menstruation. We would call this gentleman's attention to a not so small class of cases where the tumors increase after this function has entirely ceased.

I wish to offer a clinical case that was observed by physicians not particularly interested in its treatment. Miss X., æt. 34, nurse by occupation, had been under general gynecological treatment for six years. She first sought medical care on account of pelvic pain. She took at one time ergot for seven months with no results, and finally sought the advice of Dr. Skene because the tumor had lately been rapidly increasing in size. She was examined carefully by Dr. Skene, who made notes of the case at this time, and also by Dr. Lucy H. Hall when she first came under my care by the kindness of Dr. Skene. She has had twenty treatments, averaging from two to three weekly. The current used, which was as strong as she could bear with comfort, ranged between thirty and sixty milliamperes. The abdominal electrode consisted of a mass of moulding clay with thirty-six square inches of contact. The uterine electrode consisted of two square centimetres of platinum, and was the negative pole. The séances lasted from five to eight minutes. After the patient had undergone eighteen treatments she was carefully examined by Dr. Skene and Dr. Hall, and they both agreed that the tumor had decreased in size. The patient was convinced that the tumor had decreased, but stated that she had gained much in flesh. It is not uncommon for patients to rapidly gain in flesh while under this treatment. Three other cases under my care have shown decided improvement, the tumors growing smaller and the unpleasant symptoms growing less.

It is often difficult to estimate the comparative size of the tumor at different periods. The distended condition of the intestines will cause error in the calculation, and the same tumor varies at different times of the menstrual period, as it is more or less engorged with blood. The measurements, considering the ant. superior spinous processes, the umbilicus, and ensiform cartilage as test points, are defective. The best method we are aware of is that followed by Dr. Skene. He catches up the abdominal wall and makes a careful estimate of its thickness, and then places the fingers at the sides of the tumor, estimating its thickness. The same approximate measurement is made from above and below, if possible. The importance of allowing for the abdominal wall will be appreciated when we observe how rapidly its thickness is affected by the general nutrition of the patient.

HOW DOES GALVANISM AFFECT THE FIBROID?

The use of the term electrolysis, as applied to the form of treatment considered in this essay, has been avoided because, when used as a distinctive application, it is misleading. There is no more justification for the term as applied to the treatment of fibroid tumors than there is for the use of the expression for the application of the galvanic current for the relief of a sciatica. Electricity is conducted by the metals and only such fluids as it can decompose.* The tissues of the body only become conductors when fluid is present. The decomposition takes place only at the poles, and the changes that occur between them are those of atomic rearrangement. For example, if a current is applied to decompose a certain amount of water, as represented by— H^1O^1 , $H_2^2O^2$, $H_2^3O^3$, $H_2^4O^4$ —, the first molecule is decomposed, the H^1 going off as a gas to the negative pole. Molecule H_2O^4 is also decomposed, the O^4 passing off as a gas at the positive pole; this would necessitate an entire rearrangement, so that the following condition would be present: H^1 free and— $H_2^2O^2$, $H_2^3O^3$, $H_2^4O^4$ — free O^4 . This change would continually take place until all the water had become decomposed. It makes no difference whether the molecule be a simple one like water, or a complicated organic combination. This rearrangement is, as far as we know, the only chemical change that takes place; so that the term electrolysis, used to indicate some peculiar disintegration that is not always present, is clearly misapplied; electrolysis occurs whenever a current is used.

In attempting to answer the question of how galvanism affects fibroids, writers have indulged in idle speculations rather than attempted experimental research. The riddle is no easy one to solve, for the tumors vary not only in position, form, and blood supply, but differ widely as to their constituent parts. They differ not only among themselves, but the same fibroid presents marked differences at different times. During the menstrual period they may be enlarged and soft, and when it is past, relapse into their former hard condition. They often enlarge very markedly during pregnancy, and disappear as the uterus undergoes involution, as has been observed by Emmet,† Lorain,‡ Pagan,§ and Hanks.¶ They disappear at times without any known reason even in young women, but this is of so rare an occur-

* Pure carbon is an apparent exception to this.

† Emmet, *Princ. and Pract. of Gyn.*

‡ *Gazette des Hopitaux.*

§ Lambert, *des Grosses de myomes.* Thèse Paris, 1880.

¶ *Diseases of the Female Sexual Organs.*—N. Y. Med. Jour., 83, 614.

rence, that it need scarcely be considered when dealing with statistics of their treatment. It has been claimed that the cases where this was noticed were cases of hard inflammatory masses, but both Schroeder* and Gusserow† believe that it occasionally takes place. The former gentleman collected thirty-nine cases, and said that in the majority of these "the correctness of the diagnosis may be regarded as beyond question."

In considering the cause of their disappearance both spontaneously and as the result of treatment, the more cautious observers ascribe it simply to modified nutrition, and there is but little doubt that in so doing they occupy an exceedingly safe standpoint. Prof. Playfair says that "the action of the negative galvanic current in electrolysis is probably simply that of a strong stimulus to absorption." The nutrition of the fibroid may be affected in one of several ways, or by all of them combined.

1st. By affecting the blood-vessels and absorbents.

2d. By affecting the muscular tissue.

3d. By affecting the nerves.

4th. By affecting the connective tissues.

5th. By affecting the cells directly.

That the blood-vessels and absorbents play an important role several facts abundantly attest. The increase in size of many of these tumors during menstruation and their atrophy when the ovaries are removed and they are deprived of the periodical hyperæmia, attest to this. The ligation of the ovarian arteries when the appendages have been removed may in some cases have something to do with the decrease in size. The relation between the direct action of ergot on the coats of the blood-vessels and its indirect action through the muscular structure, has not been entirely determined, and another agent that probably acts much in the same way as ergot, has been recently advocated—*pinus canadensis*.‡ Gusserow states that various operative procedures—sponge tents, incision of the mouth of the uterus and intra-uterine injections, frequently cause sloughing of the fibro-miomata by interference with its nutrition through traumatism of the uterine mucous membrane.

The effect of a current of fifty milliampères can be well studied, by passing it through a portion of bared intestine of a living animal. The tissue between the poles becomes blanched and continues in this condition for some time after the current is broken. I have observed this several times, and there is undoubtedly an intense contraction of the

* Dis. of Female Sexual Organs.

† Op. cit., p. 223.

‡ Schmidt, N. Y. Med. Rec., Feb. 15, 1888.

vessels. Another important effect of the current is its cataphoric action. This takes place during the passage of an electric current through a porous body. The fluids are transferred toward the negative pole about which they accumulate. This can be nicely seen in the above-mentioned experiment, where the tissue about the negative pole bulges up from its excess of fluid. The activity of the cataphoric action is much greater with stronger currents and with more poorly conducting mediums (Erb). A familiar experiment to illustrate this action, is made by using a vessel containing water which is separated by a porous partition into two compartments. If the current is passed from one compartment to the other, the water is seen to rise in the compartment in which is placed the negative pole. The removal of a large amount of fluid from one portion of a fibroid to another must profoundly affect its nutrition, and of course this influence would be more manifest in those tumors where the fluid portion is more markedly in excess. The lymph spaces in some of these tumors are enormously dilated. It will perhaps be demonstrated in the future that many of the blood-vessels and lymph spaces are destroyed by very strong currents.

If a muscle through which the blood is circulating be exposed to the action of heat at 118 F., to distilled water, to acids, even of the weaker kind such as carbonic acid, to various chemical bodies, and to the effects of freezing and then thawing,* it passes into a state known as *rigor mortis*. In this condition it is devoid of irritability. It is strongly contracted in the direction of its length, and is less elastic; it has a whitish, curdled appearance and an acid reaction. The previously transparent muscle tubes appear opaque and flocculent, and their contents solid. The essential process in rigor is a contraction of the contents of the muscle tubes whereby they become solid. The analogy between rigor and the active state is very close, and it has been assumed that coagulation does take place when a muscle is in motion and that the product is rapidly disposed of, or that perhaps the myosin is generated with such rapidity that it has not time to pass at once into the state of gelatinous solution, but enters for a moment into the undissolved condition which does not appear under slower decomposition until considerable concentration (Gamgee). Recognizing the fact that *rigor mortis* can occur in muscular tissue while the circulation is maintained, the writer desired to ascertain if this condition was brought about by very strong galvanic currents. A dog was thoroughly anæsthetized, and a current of seventy-five milliampères passed through the wall of the left ventricle, one electrode being placed in contact with the diaphragm and the other over, and in contact with the pericardium. A piece of the muscle that was in a direct line with the

* Herman. Human Physiology, p. 281.

current was excised, and a fresh section prepared. Another section of the ventricle outside of the direct line of current was also prepared in the same manner, and they were compared and the following differences noted: In the section affected by the current the transverse striæ were much less distinct than in the other section, seeming granular, and the tube seemed much more opaque. The fibres were also less regular.* The tendency of this experiment is toward the fact that there is a direct effect on the muscle cells with the seventy-five milli-ampère current. Whether this change be due to *rigor mortis* remains to be shown. The heart was selected for the experiment because, while in many respects it is classed as an involuntary muscular structure, the striated markings of its muscle tubes render changes more readily discernible. How far we may compare the results obtained in the heart muscle with those that would exist in non-striated muscular fibres, of which the myomata are largely composed, is yet unknown.† A spontaneously coagulable substance in the non-striated muscular fibres under certain conditions may be assumed from the occurrence of a death rigor (Hermann), and the writer thinks it is not improbable that this is the condition found. If the death rigor occurs in any considerable part of the muscle tubes of the tumor there would result a marked diminution of its irritability, for it is a well-known fact that the muscle under this condition ceases to respond to stimuli.‡ It is not easy to estimate this on the living subject, but the following experiment was made with this object in view, viz.: to determine if there was any difference in the irritability of the uterus before and after treatment. As it is not possible for obvious reasons to observe the contractions of the uterus, the following indirect method was utilized.

* This experiment was performed in the laboratory of the Long Island College Hospital, and I have to acknowledge the kind aid of Dr. J. M. Van Cott, Jr., Pathologist to that institution.

† The properties of the two classes of muscles are, as far as they have been investigated, almost identical; but the respiratory and chemical changes are due to activity and the electrical conditions; the formation of heat, etc., of smooth muscles have yet to be made out (Hermann).

‡ Welsh made an interesting observation in this respect. "Once, in teasing out, in a warm room, a bit of fatty heart-muscle from one of the rabbits, I made a curious observation. Near the edge of the cover glass, where there was a slight current in the physiological salt solution, rythmical contraction was observed in a group of muscle fibres. This interesting spectacle could be watched under the microscope for ten minutes. These contracting fibres were filled with fatty globules, and only here and there, and then indistinctly, could any trace of striation be detected."—(The Cartwright Lectures on the General Path. of Fever, 1888.) This observation shows that under some conditions, even where the striæ are not to be found, contraction can take place, but probably only under most favorable conditions, for very short periods.

Contractions of the Uterus are followed by Contractions of the Vagina.—It is assumed that the contractions of the uterus are followed by contractions of the vagina which are in direct proportion to them. Kehrer* found in his experiments with rabbits, that exposure to air would give rise to a contraction which advanced through the whole genital canal, while by chemical, mechanical, electric and thermal irritation contractions could be started at almost any point and were transmitted in one or the other direction, so that an increase in the vaginal pressure would indicate a contracted condition of the uterus. This method of indicating contractions of the uterus has been utilized by Milne Murray,† of Edinburgh, in his experiments on the effects of hot water on the uterus. The following method was adopted by the author. A rubber bag by which the vaginal pressure is to be determined is filled with water and communicates by a rubber tubing with the proximal arm of a U-shaped glass tube which contains mercury. The other arm of the glass tube is opened at the end. When any pressure is made on the bag the column is pushed back, and this raises the discus of the mercury in the distal arm. The variation can be read by means of a graduated scale. The chief sources of error in using this means of measurement, arise from having air mixed with the water, or having the tube of such thin rubber that it readily becomes distended by pressure.

There are two methods of measuring the effects of stimuli on muscular contraction, one is by observing the comparative strength of the contraction, and the other is by ascertaining the smallest amount of current that will give a contraction, and the latter method was in this instance adopted. The induced current with a sliding induction coil was used. The cell used was a constant one. The patient in position, the electrode was placed in the uterine canal. The bag filled with water was then introduced, and after waiting five or six minutes for the vagina to become accustomed to it, the faradic current was very gently turned (the other arrangements being exactly similar to those used in the ordinary treatment) until contractions were induced in the uterus. The amount of this current was carefully calculated. The constant current was now gradually substituted by means of a rheostat until sixty milliamperes was registered. In about a minute the column of mercury showed an increased vaginal pressure of one-sixteenth of a pound.

The current was turned off very gradually, and the patient allowed

* "Peristalsis of the Genital Tract." Chadwick, Trans. of Am. Gyn. Soc., vol. x.

† Edinburgh Med. Journal, Aug. and Sept., 1886.

to remain perfectly quiet for twenty minutes; at the end of this time the slightest induced current that would give a contraction was considerably less than before the treatment.*

Direct Irritant Effect of the Current.—Does the current leave a condition which tends to induce firm uterine contraction, as hinted by Dr. T. Addis Emmet, when he said that he had seen diminution in size produced by an irritant such as a sponge tent which set up a strong uterine contraction, and is this diminution in size permanent? This assumption can only be discussed when some one has carefully studied the condition of the uterus several weeks before and after such treatment that is followed by favorable results.

The precise effect of the current on the nerves of the tumor is a difficult matter to determine. Dr. Martin says: "I believe that electricity powerfully concentrated as it is in this treatment in passing through these tissues has oftentimes some such destructive effect on these trophic nerves, or nerves which carry a trophic influence and thereby cut off the power on nutrition in the tissues." He refers to "peculiar irritations of motor or other nerve trunks or their branches which are supposed to contain inherently or in close association trophic influence which will oftentimes cause progressive or rapid atrophy of the tissues under their control." This theory is entirely speculative, and, while ingenious, can hardly be considered until we have more anatomical and physiological data.

The effect of the positive pole in preventing hemorrhage is, in my opinion, entirely due to its caustic effect, and could be brought about as effectively with the galvano-cautery were it possible to so use it as to bake the tissue as we sometimes do outside of the body.

The Effect on the Connective Tissue.—Dr. William H. Baker states it as his opinion, "That electrolysis establishes a process similar to that which occurs without the intervention of any outside agency that we are aware of, i. e., an interstitial inflammation of the connective tissue, and in its resulting cicatricial contraction the muscular fibres are so compressed that fatty degeneration occurs, which being absorbed the growth diminishes in its volume or entirely disappears." He cites in support of this view a case in the practice of the late Dr. Peaslee, in which such a result followed the puncture of a fibroid by an aspirating needle used for diagnostic purposes. We will concede that an acute inflammation of the connective tissue may, and sometimes does, ensue in fibroid tumors; but as it could readily result in the formation of abscesses, we believe it would be attended with great danger to the patient, and therefore not

* Unfortunately the writer has been unable to repeat this experiment, but hopes that others may do so.

desirable to attempt to produce. The so-called chronic interstitial inflammation, of which we have an analogy in the processes that take place in the kidney and liver, might undoubtedly in its contractile stage produce such a change as is supposed to have taken place in a case reported by Kidd, where the tumor, which reached midway between the umbilicus and symphysis, shrank until only a small portion could be detected. Several gentlemen have spoken of its action upon cells, "cell liquefaction," but the term is so indefinite that it reminds one of the so-called catalytic process of the physiologists.

Dr. Martin, in reviewing the causes of the action of the galvanic current, advances the following theory, which I will give in his own words. This theory involves a conception that many men entertain, as evidenced by the distinctive application to this treatment of the term electrolysis, and I believe it in my power to absolutely demonstrate its fallacy. Dr. Martin says: "Electrolysis only occurs in that part of the body which is in a fluid state. While the galvanic current passing through a soft living tissue has not an interrupted fluid medium, it has practically a fluid medium divided into innumerable little compartments, each one separated from the other by a thin wall of solid. During the passage of the current each of these particles of solids acts as a positive electrode on the fluid between it and the next solid particle in front, and as a negative electrode upon the fluid between it and the solid particle behind it. Each molecule of fluid in a conducting solid, therefore, in the line of the galvanic current may become electrolysized." He imagines a chain of innumerable compartments of tissue, in each of which an electrical reaction takes place. Either of the three following reductions would seem to prove this theory untenable:

First.—Let us suppose that four compartments are side by side in a straight line, as is represented by the following diagram—
 $(+ \text{HCl}, \text{HCl}-) (+ \text{HCl}, \text{HCl}-) (: \text{H}_2\text{O}, \text{H}_2\text{O}-) (+ \text{NaCl}, \text{NaCl}-)$ —
 the first two containing chloride of hydrogen, the third water, and the fourth chloride of sodium. If a strong current be passed through this line, the first two cells will be filled with chlorine and hydrogen gas, the third hydrogen and oxygen gas, and the fourth with chlorine gas and sodium. Just imagine how the tumor would balloon up immediately after treatment!

Second.—The counter-current, besides the internal resistance in each of these little particles of tissue, would make an enormous counter-resistance, and would be out of all proportion to what we know must exist.

Third.—If the membrane is dry and does not permit the current to pass, no reaction can take place; and if any moisture exists, no such action would take place. Further comment is unnecessary.

Dr. W. Woodman Webb very frankly remarks: "With regard to the mode of action of electricity used curatively in such cases, we must for a time be contented with knowing the fact that it does what we propose to do in a manner safe, comparatively easy, and in a reasonably short space of time."

Experiments on Fibroid Tissue.—How the electric current brings about the arrest of the tumor growth and its diminution of size, has given rise to much speculation. The effect is produced either at the poles or between them, and I have studied these effects on fibroid tissue outside of the body. A piece of fibroid tumor about six centimetres square is so cut that it presents as its upper surface a smooth plane of white tissue with a pinkish tinge. The end of a platinum probe and of a piece of copper wire of about the same size are allowed to rest on the tissues about three centimetres apart. If now a current of twenty milliamperes be used, the first thing noticed will be a white froth at both poles, and the odor of a gas which is soon perceptible throughout the room. If this froth is brushed aside, there will be noticed, extending directly from either pole, a circle of brown color,* which at the end of three minutes is fifteen millimetres in circumference. I have named these portions of changed tissue about the poles for convenience the positive and negative polar masses. The color is very similar to that of tissue that has been slowly baked by Keith's method. At the end of fifteen minutes the size of the circle has not increased very much, but certain other changes have taken place. The periphery of the positive mass is depressed, leaving the sharp-cut border of the surrounding tissue. The centre of the brown patch is slightly higher than the surrounding structure, and slopes down symmetrically to the periphery. At the apex, where the probe has been in contact with the tissue, a dry, whitish appearance is observed. We make a section through this brown mass from above downward, and find the color is lighter than on the surface, and that the vertical distance is about equal to the horizontal surface measurement of the mass. The mass is hard when pricked with the point of a needle, and the reaction of the exuding fluid markedly acid.

At the negative pole a band of tissue of a reddish brown color extends outward from the positive pole in about the same time and of about an equal distance. It is not so circular in outline, however, and, although there is a distinct line of demarkation between it and the surrounding tissues, it is not so well marked as in case of the positive mass. The edges are also elevated slightly, sloping up toward the centre, which is the highest point. A vertical section from before

* No two people to whom I have shown this experiment could agree on the color.

backward, and from side to side, shows the mass to be semi-hemispherical. The color is a dark red, and has a jelly-like appearance. It is soft when pricked with a needle, and is full of fluid. If the surface of the mass is touched with litmus paper, the paper instantly turns a deep blue.

After passage of the current for some time, the conductivity of both masses is decidedly diminished, as is shown by an attempt to pass the current directly through either of them. A narrow strip of tumor, one and one-quarter inches long, a half an inch wide, and three-quarters thick, was placed between the electrodes, and fifteen milliampères of current indicated by the meter. The masses gradually developed from the ends, and continued to spread until they met. Shortly after this took place, the milliampèremeter ceased to register any current. A larger piece was used with the same current, and the conductivity became greatly diminished before the areas were in contact. The reactions to litmus paper that have been noticed were strictly confined to the polar masses.

Some of the changes that take place in the polar masses have been mentioned. In order to determine whether they occur to any extent in the intermediate portions, the following experiment was made. Three portions of the fibroid tissue were placed in a line and the electrodes applied to the terminal pieces. As soon as the polar masses approached the middle piece, new terminal pieces were substituted, and this continued with a fifteen milliampère current for over an hour. The changed tissues always extended from the pole by continuity and no change could be noticed in the intermediate piece of fibroid. When the pieces were finally left the masses spread through the intermediate portion. No change could be detected in the intermediate portion before extension of the polar masses, either by the unaided eye or the microscope. It was also desired to know if the central portion had suffered any diminution in weight, so it was carefully weighed before and after the experiment. To guard against the error arising from the evaporation of water from it, a piece of about the same size was placed on the table near it and also carefully weighed before and after the experiment. By comparing the weighings, it was found that the intermediate portion sustained no loss except by the evaporation of water from its surface.

These experiments show that with the use of strong currents that the polar masses represent considerable areas of tissue that have become greatly changed, and so far as they encroach upon the nutritive supplies to the tumor so far must they modify its growth. The experiments cited show that they are not unimportant factors.

Method of Using the Current.—It may be applied in one of two ways.

First. By puncturing the tumor by one or both electrodes through the abdominal wall.

Second. By the method of Apostoli ; this consists in passing a powerful current through the abdominal wall by means of a large discharging electrode.

Of the first method we can say but little in its favor. That it is attended with danger one fatal case reported by Dr. Freeman (and we believe that there are others that have never been reported) and the frequent cases where large masses slough out after the treatment will attest.* We have yet to hear of a case where unfortunate results followed the use of Apostoli's method and where the currents used were less than one hundred and fifty milliamperes. If one elects to puncture through the abdomen, in spite of its dangers, a round pointed needle insulated to as near its point as the amount desired to be exposed, should be used. There is a decided objection to a steel needle that is covered by shellac as an insulating material. It may become broken, and if this was not noticed, its use, particularly where the patient is etherized, might be attended by the most serious consequences. Before puncture the abdominal wall should be made surgically clean and the needle likewise. All antiseptic precautions should be scrupulously followed. It often requires great force to insert the needle into the tumor. The abdominal puncture, in the opinion of the writer, should not be used, because equally good results are obtained by a safer method. It is more dangerous than Apostoli's method, because :

a. The needle may introduce septic matter.

b. If sloughing does ensue, a tract is left by which pus might find its way into the abdominal cavity.

c. If there be diseased appendages, for example, a tube filled with pus, this would be emptied into the abdominal cavity.

d. If large veins are punctured, and these are sometimes present on the outside of the tumor as large as my thumb, (as the writer can attest by personal experience) serious hemorrhage may ensue.

Apostoli's Method of Treatment.—For this treatment four things are necessary : a milliamperemeter to determine the strength of the current ; a rheostat, so that the current may be gradually increased and diminished ; electrodes, and a battery.

The Milliamperemeter.—This consists of a galvanic needle so arranged that it is affected by a current passing in certain relations to it. The ampere is the unit, but as only a small part of the unit is used the instrument is graduated in one thousand parts, or a milliampere. Even

* This criticism is also applicable to those cases where currents of excessively high intensity are used.

approximately accurate instruments have been until recently very costly, but there are, however, now in the market several that are reliable enough for the purpose of the physician. I have used the milliamperemeter of Mr. John A. Barrett, and found it entirely satisfactory. So much has been said of the impossibility of procuring an instrument that was at all reliable in this country, that I took the trouble to determine the error in my own instrument, which is less than four per cent; this is sufficiently accurate for practical purposes. The error of a Hirschman instrument that had recently been imported was found to be more than this.

By means of a shunt the instrument can be made to register up to two hundred and fifty milliamperes, which is a greater current than I believe warrantable. Dr. Playfair says that: "Apostoli's galvanometer is only graduated up to two hundred milliamperes, and he never exceeds this and generally works with lower intensities, at least with the negative pole. The action of the negative galvanic current in electrolysis is probably simply that of a strong stimulus to absorption not of a cautery . . . the lesson to be learnt from which is probably that very high intensities should be avoided."

Without the shunt the resistance is one hundred and fifteen ohms, as I have personally measured, and with it it would be reduced to an insignificant amount.

The Rheostat.—By means of this instrument introduced into the circuit, the current can be as gradually increased or diminished as is desired. The principle of its construction is the insertion or withdrawal from the current of a definite amount of resistance. Water is most commonly used for the resisting body. Two plates of metal are so arranged that they can be brought in contact or separated under water at will. When in contact the whole current passes, but when made to separate the current is proportionately diminished. Most of the water rheostats have been very imperfect in action. The best that we are acquainted with is that invented by Mr. Bailey. It consists of two plates of carbon that are gradually lowered into the water. The writer used this rheostat for some time, and the only objection to it as a non-portable instrument was that water would sometimes remain between the plates, so that when the current was turned on the patient would immediately feel the effect of five or ten milliamperes. This is enough to cause a disagreeable shock. Its large size prevents its being easily carried about.

Mr. John A. Barrett has invented a rheostat that seems to be perfect. It may be used with a powerful induced current, and will increase it so gradually that if the electrodes be placed on the tip of the tongue it is impossible to say just at what time the current commences. Its

principle of construction is that of compressing a substance containing carbon in a finely divided form. The greater the pressure the less resistance offered to the passage of the current. It can be carried about in the coat pocket. Its minimum amount of resistance is less than fifteen ohms. Three things are desirable in a good rheostat: It should be portable, it should allow the current to be increased and diminished without jerkiness, and its minimum amount of resistance should be small.

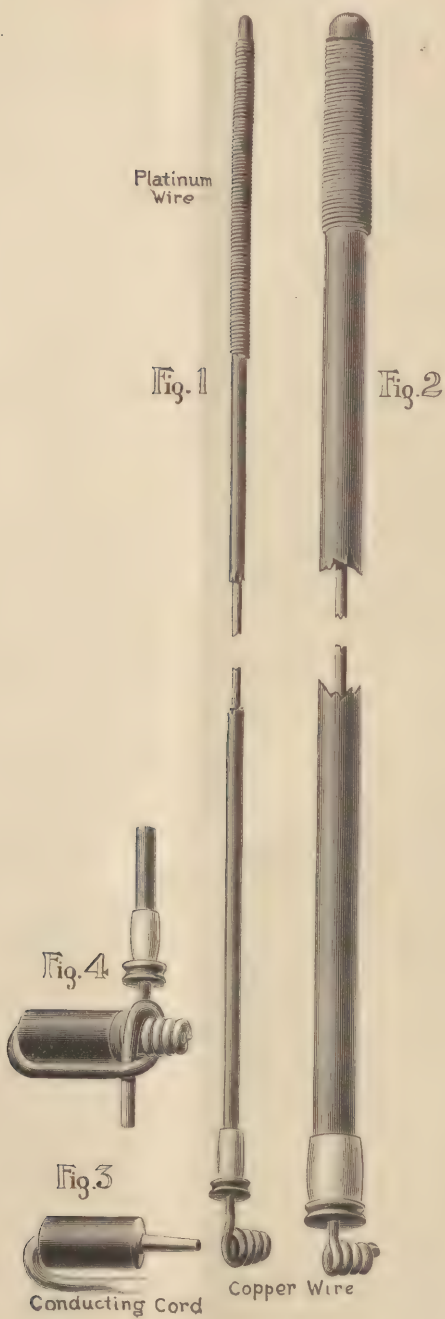
Electrodes.---The electrodes are two in number, an abdominal or dispersing electrode and a uterine electrode. For the dispersing electrode we must have a broad surface that will intimately adapt itself to the abdominal wall. If it does not do this, the points of greatest contact may become blistered. Dr. Apostoli used a plaque of clay, which was covered by a copper plate. This answers the purpose admirably, but the wet clay soils the person and clothing of the patient as well as of the operator. Dr. Martin devised an electrode which consisted of an animal membrane tightly stretched over a hemisphere of metal, having the space between the membrane and the metal filled with salt water. I have never used his instrument, but some of my friends have discontinued its use because of its readiness to leak. Punk and other materials have been used, and Dr. Rockwell recommends simply cotton well saturated and covered by the metallic plate. Dr. Skene has found this sufficient. I believe this will answer the purpose if only enough cotton be used. The size of the plate is a matter of no little importance, and the most accurate way of designating it is by expressing its area in square inches, and from thirty to eighty square inches or more are used. By using an adjustable clip to the copper electrode a separate one may be cut from a roll of copper for each patient, at a trifling cost.

The Uterine Electrode.---This should be made of a metal that will not oxidize by the passage of a current, and platinum is found to be most serviceable. It is of the utmost importance to have the electrode in close contact with the walls of the uterine canal; and from what we read, I am inclined to believe that when a good apposition is secured it is rather the result of accident than of adapting a means to an end. Dr. Martin speaks of two sizes, one with a diameter of three and the other of five millimetres. I believe that there should be at least three sizes, one of two millimetres, one of five millimetres, and one of seven millimetres. The length of the platinum portion of this instrument should be such as to give about four square centimetres of contact when used with a current of a strength of fifty to one hundred milliamperes for five minutes. I have adopted Dr. Martin's suggestion in this case. I am sure that any one who thinks it an easy matter to pass a probe

through the meandering path of a uterine fibroid, has thought he accomplished the result when this was not so, or has had a slight experience and that with favorable cases. Aside from the difficulties of passing the uterine electrode, the variations in the size of the uterine canal should not be forgotten, and for this reason I insist upon at least three sizes of electrodes. The size of the canal varies so much with different degrees of contraction of the uterine tissue that we rarely find it in the same case twice alike. After menstruation, while the patient is undergoing treatment, the canal is very small; while ordinarily, the reverse is the case. And while I have as yet observed too few cases with the object of noting this condition, to speak with any degree of positiveness, yet I am strongly inclined to believe, from clinical observation, that in the case of a fibroid rapidly increasing in size we will find after each menstrual period the os dilated sufficiently to introduce one or two fingers. I have never seen this stated, but believe it to be worthy of investigation.

Platinum is a costly metal. The expense of having so many electrodes is an important factor. I went to one instrument maker who stated the price of the uterine electrodes after Apostoli's model would be \$40.00. I have overcome this difficulty, and an efficient and convenient platinum electrode may be had for about \$3.00. The expense of the instrument is mainly caused by the amount of platinum used. Martin proposed to overcome this by using platinum wire and winding it about a copper core. If the positive electrode of a current passing through a portion of a fibroid tumor consist of two terminal ends, one of platinum and the other of copper, the electrolytic action will be very much greater at the copper termination. If a current of ten milliamperes be continued for ten minutes, and the tissue then divided, it will be seen that the green solution of copper has been diffused through the mass of tissue. This indicates the danger of having the slightest amount of copper exposed. To overcome the objections, and at the same time to utilize the economical suggestion, I make use of the following expedient. An ordinary bougie is selected, of the desired diameter, and the butt removed. A piece of copper wire is now adapted to the cavity. The distal end is wound with a thin piece of platinum wire for the required length, and the end of the wire pushed through the rubber and into a hole bored into the copper; by pinching the copper core, it is fastened. The copper wire, which projects about an inch and a half from the butt, is now wound in a spiral, so that an effective connection is made, and we then have an effective electrode that meets every practical requirement. This electrode should be cleansed by means of a nail brush and soap and cold water.

Dr. Skene Keith says, in regard to a flexible electrode: "We are



told in Dublin that it is necessary above all to have a good knowledge of pelvic diagnosis; yet flexible electrodes are advocated because they are more easy of introduction than rigid ones, and can be got into the cavity when a rigid one cannot. What is this but an acknowledgment of the want of the first great essential—a knowledge of the diagnosis and manipulation." We agree with what was said in Dublin, and disagree entirely with Dr. Keith's supposition. We have been able to introduce, for example, our flexible electrode into the tortuous cavity of a fibroid that had been removed from the body, where it would have been impossible (?) to have accomplished it with one more rigid; and if this is so outside of the body, where one certainly has all the aid that could be furnished by the most accurate diagnosis, how much more is it true with the living subject?

The Battery.—It is foreign to my purpose to discuss the relative merits of the many different batteries in the market. A good battery should be constant in its action; if it is not so, there will be marked variations in the current. This is apt particularly to occur when working with high intensities, and it is caused by the decomposing fluid in the cell preventing its efficient action, both by covering the elements and causing a counter-current. I have used the Law cell with satisfaction; and when I desired a current of forty milliamperes or under, Barrett's fifty-cell chloride of silver battery has proved itself entirely competent. It is necessary to have from seventy-five to one hundred and fifty cells to obtain a current of very high intensity.

For the past few months I have used a battery that I improvised. It is economical and effective. The ordinary wide mouth quart fruit jar is used. Several layers of thick pasteboard are cut so as to fit into the neck of the bottle, and more pasteboard covers so cut that they project slightly over the side of the glass rim at the mouth of the bottle. These are tacked together and perforated by means of a carpenter's chisel, so as to permit a carbon plate six inches by one and a half inches by one-quarter inch to be pushed through it. A perforated punch, No. 11, will make a hole that will allow the zinc element to pass through. The elements are submerged in a solution of chloride of ammonium, the connections made, and the battery is ready for use. To those to whom the expense of a battery is quite an object and who have some mechanical ability, it is not difficult to prepare, and it will work as well as any in the market. Its cost, if the materials are obtained at wholesale rates, is about \$15 per hundred cells.

Method of Application.—The patient is placed on a table with the clothes about the waist loose and so arranged that they can be readily pushed aside. The dispersing electrode is placed in a basin of very hot water and then adjusted to the abdominal wall. It is well to allow

it to remain for as long a time as convenient before using the current, for the skin becomes a very much better conductor when soaked with water. The resistance of the horny layer of the skin is so great that Erb says all others need scarcely to be considered, and from this statement it will be seen that it is important to have it well soaked, as by this means alone its resistance is to a great degree overcome.*

The rheostat and milliamperemeter should now be placed in the circuit and the uterine electrode fastened to the rheostat. The battery may be short circuited for a moment, and if one is not positive as to which is the negative terminal, place the bare terminations in a glass of water, and it will be distinguished by the greater number of bubbles collecting upon it. The rheostat should now be so placed that no current is permitted to pass. The uterine electrode may now be inserted. This is often the most difficult part of the treatment and requires the *lactus eruditus*. I usually do this on the back, but sometimes it is necessary to turn on the side, and then the patient gently turned over on the back. The current may be gradually increased until the patient feels pain. The strength of current that a patient is able to bear without pain varies greatly. In some cases the patient will bear one hundred milliamperes, while in others it is impossible to go over thirty milliamperes. One cause of pelvic pain is an overloaded condition of the bowels, and particular attention should be given to have them empty. After the *séance* it is better for the patient to lie down for a short time. When the treatment is used for the purpose of checking hæmorrhage, the patient should remain in bed and keep very quiet for forty-eight hours.

We are quite sure to have the good results obtained by a new method of treatment called to our attention before we learn of its casualties, and this is true of the subject under consideration. When using currents of great strength we are dealing with an agent capable of doing much harm. To those who are not specially familiar with the use of electricity it is almost impossible to conceive of a patient being able to bear with comfort a current, say of one hundred milliamperes, that has been *gradually increased*, when to apply suddenly a

* While a saline solution will overcome its resistance much more effectively than simple warm water, the latter is to be preferred, as may be demonstrated by the following experiment: Allow a current as strong as comfortable to traverse any part of the body, using simple water to moisten the electrodes; lessen the current, and, after moistening the electrodes with the saline solution, increase the current to its maximum, consistent with comfort. It will then be found that the current's strength is much less than it was with simple water; and, as it is difficult to work with as much current strength as we desire in a number of cases without anæsthesia, on account of the pain to the patient, the disadvantage of the saline solution is apparent.

current of less than thirty milliamperes may occasion intense suffering. The ability to bear the current might not inaptly be compared to the ease with which one can pass over the ground on an express train; but the train starts very gradually and also decreases its speed gradually. Should it attain or discontinue its maximum speed abruptly, serious trouble would ensue. The importance of making secure connections in order to avoid abruptly breaking the current should be borne in mind. Stirring the connecting cords will at times prove disagreeable, as will likewise shaking the table. Using the positive pole inside of the uterus may give rise to a stenosis, as occurred in a case that came to my notice. A nurse was permitted to give the treatment, and from the contracted condition of the canal it is presumed that she used the poles improperly. This illustrates the danger of indiscriminate use of this method. It should never be used except by an expert. A current strong enough to throw a patient off a table by causing powerful muscular contractions, is one that is not to be trifled with, and a wet towel or any conducting substance that would switch suddenly a current of great strength through the heart or nervous centres, might prove fatal. In short, all the dangers have probably not yet illustrated themselves, and like any other new procedure we should be on our guard for danger signals. Before closing this paper, I should be ungrateful if I did not acknowledge the kindness of Mr. John A. Barrett, to whom the medical profession is greatly indebted for his inventions, whereby he has enabled them to utilize an agent whose usefulness, without his aid, would be much more restricted.

